MEDIUM ACCESS CONTROL SCHEME FOR DATA TRANSMISSION ON CODE DIVISION MULTIPLE ACCESS (CDMA) WIRELESS SYSTEMS

FIELD OF THE INVENTION

The present invention relates to the use of code division multiple access to support data transmission systems. More particularly, the present invention relates to wireless access synchronization techniques to support integrated services in third generation personal communications systems and as the wireless access technology for local area networks.

DESCRIPTION OF RELATED ART

Code division multiple access (CDMA) systems, also known as CDMA wireless access systems, are comprised of a plurality of base stations interconnected by one or more switching systems. Each base station serves a particular geographic region referred to as a cell. Within each base station's cell are any number of mobile terminals. The function of each base station is to transmit data between its respective switching system and the mobile terminals assigned to its cell. The base station transmits the data to the mobile terminal over radio channels, which are also known as downlinks. Conversely, the mobile terminals communicate with their assigned base station over radio channels known as uplinks.

Typically, the base station maintains track of its assigned mobile terminals by continuously transmitting a pilot signal containing timing markers on a specific downlink channel. This continuous transmission allows the base station to maintain synchronization with its assigned mobile terminals. Such synchronization in turn enables the base station to transmit data to any given mobile terminal as needed.

In addition to achieving synchronization on the downlink channel for sending data, a base station also synchronizes with its assigned mobile terminals via the uplink channel to receive data by using a synchronization message. Synchronization messages are transmitted by a mobile terminal when it initiates a call. Like the pilot signal, the synchronization message also contains timing markers to which the receiver on the assigned base station synchronizes at the beginning of a call. Once the uplink channel from the mobile terminal to the base station is established, the base station uses additional timing information contained in on-going transmissions from the connected mobile terminal to maintain synchronization.

The synchronization requirements and the procedures discussed above are specified in EIA/TIA standard IS-95, which is discussed in detail in the 1992 Qualcomm Incorporated's primer entitled "An Overview Of The Application Of Code Division Multiple Access (CDMA) To Digital Cellular Systems And Personal Cellular Networks."

One shortcoming of this widely used synchronization standard is that it only performs well in regard to voice services. For example, synchronization messages are inapplicable for other types of cellular services because such cellular services do not maintain frequent enough contact with their respective base station to maintain synchronization. Accordingly, if the system is used to provide packet data services, or any other services in which the mobile terminal to base station transmissions are infrequent bursts, the base station may lose synchronization with its mobile terminals.

Several methods have been proposed to avoid the loss of synchronization at the base station during packet data calls.

For example, in an article entitled "Open Multi-Rate Radio Interface Architecture Based On CDMA", Proc. of 2nd International Conference on Universal Personal Communications, pp. 985–89, October 1993, A. Baier disclosed a method in which mobile terminals continually transmit a low bit rate physical control signal to the base station between data bursts. The base station would in turn use the physical control signal to maintain synchronization with the terminal between data bursts. This method is referred to in this patent application as the continuous transmission medium access control (CTX-MAC) scheme.

However, the CTX-MAC scheme is not very practical in that it requires the reservation of an uplink channel for each mobile terminal engaged in bursty data transmission. Accordingly, even if a mobile terminal's use of its assigned channel to transmit data bursts was very infrequent, the assigned channel could not be used by any other mobile terminal and in effect would be rendered useless whenever the assigned mobile terminal ceased transmitting. Additionally, the receiver on the base station must remain active at all times for each "on-off" source. An "on-off" source is one that alternates between periods when it transmits data and periods when it has no data to transmit.

A variation of the CTX-MAC scheme which serves on-off sources with small duty cycles, i.e., the ratio of the on-period to the off-period, can achieve considerable savings in base station hardware, such as eliminating individually assigned receivers, if the transmission from the individual mobile terminals is discontinued during the off-periods and the hardware is shared among different users. In order to implement this variation, which is known as the discontinuous transmission medium access control (DTX-MAC) scheme, a synchronization message must be transmitted at the beginning of each on-period to allow the base station to acquire synchronization with the transmitting mobile terminal. The synchronization message also serves to inform the base station that a particular mobile terminal intends to transmit. In this DTX-MAC scheme, all mobile terminals use the same PN code to send their synchronization message on the synchronization-reservation channel. Using the same PN code on the synchronization-reservation channel avoids the need for a separate receiver assigned to receive communications from a mobile terminal even though that mobile terminal is in the off mode. Even though there may be a need for more than one synchronization-reservation channel if the number of mobile terminals is large, the number of synchronization-reservation channels should be kept as small as possible in order to reduce complexity at the base station. Several protocols have been established to allow the single receiver to accept and process the numerous synchronization messages originating from the numerous mobile terminals. For example, one approach allows the mobile units to send synchronization messages in an asynchronous fashion, which is also known as the ADTX-MAC scheme. However, one of the shortcomings of the ADTX-MAC scheme is that collisions may occur among the numerous synchronization messages sent by their respective mobile terminals. At a given time only one mobile station can attempt to access the uplink to establish synchronization. If two or more mobile terminals transmit their synchronization messages, which the IS-95 standard refers to as a preamble, a collision occurs. If two or more of the mobile terminals have a relative delay of less than a chip duration, then destructive collisions occur and all terminals must retransmit at a later time. If all relative delays are greater than one chip duration, then depending on the receiver design used, the first arriving mobile terminal may be able to successfully